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APOLLO MONTHLY PROGRESS REPORT (U)

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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PROGRAM MANAGEMENT

STATUS SUMMARY

As a result of joint NASA-S&ID discussions, Master Development Schedule 6 was approved and issued. This new schedule extends the manufacturing completion dates for all spacecraft and includes boilerplates 26 and 27 as backup vehicles for micrometeoroid experiments and dynamic tests.

The first boilerplate 3 drop test, using a cluster of three ringsail parachutes, was successfully conducted during the report period. There are four tests with boilerplate 3 in this series scheduled prior to testing of boilerplate 6 at WSMR. Nine mock-ups have been completed and accepted by NASA; one was delivered to Houston.

Mock-ups 5, 18, and 2 have been accepted by NASA, completing the mock-up requirements for the Apollo program.

The following parachute drop tests were successfully performed during the report period: three tests with the Pioneer single, solid chute; four tests with an upper-half solid, lower-half ringsail single chute; one test with a cluster of two half-ringslot and half-ringsail chutes; and one drogue test. A cluster of two half-solid, half-ringsail chutes failed to perform satisfactorily.

The launch escape tower static test firing was conducted during the report period. Preliminary motor performance data indicated both launch escape and pitch control motors performed successfully.

A 3-week study was made to determine the feasibility of using a fixed-position crewman's couch in the command module instead of the existing variable position couch design. NASA approved the fixed-couch concept.

The qualification program on the tower jettison motor was started during the report period. The first vibration test motor was successfully static-tested.

CONTRACTS

Cost Proposals

A budgetary and planning estimate was completed on the cost for maintenance of the gantry and associated air-conditioning unit.

ASSOCIATE CONTRACTOR RELATIONS

S&ID and Grumman are jointly formulating analysis programs on space heat transfer, environmental control system, and propulsion. Analyses previously performed by S&ID form the basis of data and computer programs provided to Grumman.

SUBCONTRACT STATUS

The negtiation bases for ten of the major subcontractors have been presented to NASA for review. Contracts are being written for those five contractors with whom negotiations have been completed. Negotiations are currently in process with seven additional contractors. The target dates for completion of these negotiations are as follows:

Subcontractor	Target Date
Aerojet	May 1963
AiResearch	May 1963
Collins	May 1963
Marquardt	May 1963
Minneapolis-Honeywell	June 1963
Northrop-Ventura	June 1963
Pratt & Whitney	May 1963

NEW PROCUREMENTS

During the report period, the following contractors were selected: Link Divison, General Precision Instruments, for the mission simulator; Simmonds Precision Products for the propellant quality indicating system; and Giannini Controls Corporation for the propellant gauging system.

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Orders are in process for the following items and are scheduled for placement as indicated:

Items	Target Date
2 kmc antenna	May 1963
Beacon antenna	May 1963
In-flight test system	May 1963
TV camera	May 1963
Pyrotechnic batteries	May 1963

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DEVELOPMENT

TECHNOLOGY

Flight Performance and Control

A review of the optimum test conditions (S-1 abort parameters) for boilerplate 22 was made. It was recommended to NASA that the test condition be changed from a simulation of abort at 180,000 feet, Mach number 4.5, to an abort at 60,000 feet, Mach number 2.25. The latter condition is the highest altitude at which high dynamic pressure must be considered in a launch escape subsystem (LES) abort situation. The 60,000 foot test is desirable because it will demonstrate two possibly critical aspects of abort: any destabilizing effect of large LES motor plumes on the command module, and the ability of the command module reaction control subsystem (RCS) to arrest module rotation following tower jettison. Tower jettison occurs at the maximum dynamic pressure when abort takes place at 60,000 feet.

The service module RCS propellant requirements for roll control of the S-IVB booster, lunar excursion module, and spacecraft during three earth orbits were investigated as a part of the S-IVB Apollo control and interface problem. For six-roll orientations with a maneuver rate of 0.2 degrees per second, the propellant required is two pounds; this propellant requirement is increased to five pounds for a maneuver rate of 0.5 degrees per second. An additional 1.5 pounds of propellant is required for coast attitude control (±0.5 degrees deadband) and minimum impulse control during navigational sightings (19 sightings assumed).

An analysis to determine what additional velocities are necessary to perform translunar injection from three successive orbits has been completed and correlated with propellant reserve data. Injections performed from other than the intended orbit will require a plane change of approximately 3.8 degrees per orbit for the most unfavorable orientation of the earth, moon, and parking orbit. The current NASA S-IVB lunar launch window propellant reserves (60 meters per second or 197 feet per second) are sufficient only to accomplish this plane change maneuver. Therefore, translunar injection could be performed from any of three successive parking orbits. The first and third orbits would require a plane change of equal magnitude; the second orbit would require no plane change for injection.

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A generalized study of transearth entry loci and entry range requirements as a function of lunar declination was completed. Landing site latitudes ranging from 0 to 30 degrees and inclinations of the trajectory plane to the equatorial plane ranging from 0 to 60 degrees were considered. The resulting information is being used to evaluate several combinations of entry constraints, to establish a preferred entry technique.

Thermal and Fluid Dynamics

Tests are being conducted and studies made of the basic propellant management techniques relative to propellant settling with the RCS engines and the associated slosh and geysering. It was determined previously not to use positive expulsion of the service propulsion subsystem (SPS) tanks.

An analysis comparing subscale SPS AEDC test data on the Columbium-titanium nozzle and simulated aft bulkhead with analytical predictions was completed. Results showed close correlation between calculated values and the actual emissivity values determined by the firings.

A comparison of the gas dynamic parameters affecting solid propellant exhaust impingement on spacecraft windows (during tower jettison) was made for both Mercury and Apollo. Results indicate the total mass contacting the windows is slightly greater for Apollo, and the drag force from the exhaust, which tends to remove the deposits, is much greater for Mercury. The presence of window deposits on Mercury flights indicates the same visibility problem must be resolved for Apollo.

The effects of radiation interchange between the SPS nozzle extension and two aft bulkhead heat shield configurations have been determined, considering engine gimbaling and engine duty cycle. For an engine location 10.5 inches aft of the present location, the results indicate respective maximum nozzle temperatures of 2417 F and 2356 F for the 160-inch round and 11-inch flat toroidal heat insulation shield configurations. These temperatures are within design limitations.

The proposed air vent for the cavity between the inner and outer structure of the command module was studied to determine the feasibility of employing a heat sink, such as heat exchangers, during reentry pressurization. Results of this study indicate the enthalpy of the gas entering the cavity may be lowered to a safe level by using a heat sink of reasonable weight.

Electron densities around the command module during atmospheric entry have been estimated for five altitude-velocity combinations in the ranges of 200,000 feet to 280,000 feet and 25,000 feet per second to 36,000 feet per second, respectively. Electron density is in the range of

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10^{12} to 10^{13} electrons per cubic centimeter in all cases, which exceeds the maximum electron density at which radio communication is possible.

Preliminary results from the launch escape vehicle—service module separation tests, using a hot jet-effect model, showed a significant increase in launch escape vehicle drag due to proximity effects during separation from the service module at transonic Mach numbers. These data are being used to formalize separation techniques.

Large amplitude (±20 degrees) free oscillation dynamic stability tests of lunar excursion module and command module models, with and without strakes, have been completed. Angles of attack and sideslip calibrations of a Nortronics Q-ball also have been conducted.

A cold flow jet effects model of the launch escape vehicle has been designed, constructed, functionally checked out, and shipped. It will be tested to investigate further the stability of the launch escape vehicle during LES operation and to obtain data on the jet plume impingement area on the command module.

The oxygen pressure and temperature in the command module at the end of the first five minutes of emergency flow following a meteorite puncture were determined. With an emergency oxygen flow rate of 0.67 pounds per minute, the final conditions are 3.8 psia at 65 F. The minimum temperature of the emergency oxygen entering the command module cabin was assumed to be 275 F.

Preliminary analysis of available solar radio frequency emission data shows an optimum frequency for a solar proton warning detection system to be between 1000 and 3750 megacycles per second.

The capacities of the cooling systems for boilerplates 13 and 18, with thermal insulators under the coldplates, uninsulated coolant tank and lines, and with all telemetry equipment on full power during orbit, were analyzed and found to be adequate.

Life Systems

A study was conducted to determine the feasibility of using a fixed-position crewman's couch in the Apollo command module instead of the existing variable-position couch design with the following conditions assumed:

1. Vehicle center of gravity is controllable to maintain a lift-to-drag ratio of 0.5.

2. Couch is fixed with a 2-degree back angle.

[redacted]

[redacted]

3. Open-hip angle is as large as possible.

4. Astronaut's legs clear the main instrument panel and feet clear the guidance and navigation panel located at the lower equipment bay. Impact attenuation is provided in the footward direction so that differential foot and torso attenuation allow the hip angle to close during attenuation.

5. Any requirement for repositioning of the crew during docking will not affect the major couch structure in any way.

Employing preliminary mock-up analysis and data on center of gravity shifts, attenuation kinematics, and a revised configuration obtained from the 2-degree back angle, fixed-couch studies were made of body clearances and redefined reach and vision envelopes.

Optimum controller location was determined. The necessity and extent of relocation of the instrument panel and rearrangement of the controls and displays were studied. Necessary restraint harness modifications were considered. A preliminary insight was gained into design effect on mission phase, crew tasks, and performance interfaces. Design interfaces were coordinated and the resulting data integrated for final evaluation.

NASA reviewed the study findings and authorized S&ID to incorporate the fixed-couch concept. The concept has the advantage of simplified design, elimination of position adjustments by the crew, and improved crew acceleration environment during reentry. Open-hip angle can be established at 108 degrees to provide greater astronaut comfort and to allow closure of this angle to 66 degrees, resulting in improved restraint under impact. In general, crew mobility, comfort, capability, and safety will not be compromised.

The use of the fixed couch will require relocation of the main and side display panels and repositioning of the translational and rotational hand controllers. Crew members will be required to adjust their normal position on the fixed couches for proper viewing during rendezvous and docking operations.

To implement these changes, further studies will be required including mock-up studies to determine functional arrangement of display and control panels. Visual aids for viewing of tower jettisoning and parachute deployment, where necessary, will be evaluated. The requirements for viewing the horizon through the side windows by an astronaut in a restrained position on a fixed couch will also be studied.

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Simulation and Trainers

The Apollo entry phase is being simulated by computers. Results indicate sufficient analog computer accuracy exists for establishing most initial design parameters relating to the entry systems. It will be necessary to employ digital computing devices only in critical computational areas.

Current Apollo spacecraft system configurations and requirements are being used to adapt the present simulator to support investigation of the entry survival system. A control stick and simple panel instrumentation are being added to provide basic information and control for pilot operation. This study will be incorporated in the evaluator 1 simulation complex during the next report period.

Structural Dynamics

Differences in stability between the 1/10 scale model and boilerplate in water impact drop tests have been resolved by sealing the gap between aft heat shield and side walls on the boilerplate. Initial tests with this gap sealed have shown excellent agreement with the model tests.

Tests using the 1/10 scale model indicate a command module with 0-degree roll attitude at impact will come to rest in the over-turned stable position for horizontal velocities in excess of 10 to 15 feet per second.

A 1/10 scale model is being designed and fabricated to extend flotation stability investigations. It will have provisions for changing weight and center of gravity position, and a variable flooding feature. The latter will permit simulation of water landing and flotation stability sequence wherein the vehicle flotation attitude changes as water enters the skirt areas.

It has been recommended to NASA that a birdcage (structural skeleton) boilerplate be used for land impact testing. This type of boilerplate allows evaluation of structural deformation properties at impact at a fraction of the cost of an actual command module.

A study was initiated to demonstrate the structural integrity of boilerplate 13 service module when exposed to acoustic excitation generated during flight from Mach numbers of 0.7 to 1.6. As a result of this study it was decided to relocate five vibration pickups on boilerplate 13 but to retain the 15 pressure measurements currently scheduled.

Vibration measurements on boilerplate 6 were changed from ±50 g to ±200 g because of preliminary results from the LES tower-engine static firing. This is a precautionary measure as high vibration levels measured in the static firing are probably attributable to the support/restraint system used in the test.

SPACECRAFT AND TEST VEHICLES

Structures

The first drop test of boilerplate 3 was conducted successfully on 3 May. This test evaluated the earth landing subsystem (ELS) under conditions approximating those anticipated for the pad abort test of boilerplate 6. The drop was initiated at 13,000 feet. Operation of the stabilization chute, jettison of the apex cover, deployment of the drogue and pilot parachutes, inflation of the main chute, release of the aft heat shield, and impact conditions occurred as programed.

One land drop and 16 water drops of boilerplates 1 and 2 were conducted during this report period. Results have identified the variations in stable floating attitudes that are produced by boilerplate roll orientation prior to impact. At high g levels, the boilerplate comes to rest in an upright stable position. At low g levels, the boilerplate comes to rest in a stable position with the docking hatch below the water line. Impact g levels with boilerplate suspension angles of 30 degrees were approximately half the level of those at a 5-degree pitch angle.

The spacecraft service module radial beam successfully sustained 100 percent limit load for end boost and maximum q conditions without permanent set. The beam carried 109 percent ultimate load for both maximum q with negative external air pressure requirements and maximum q with positive external pressure requirements prior to failure under the latter condition.

Radiation testing of command module window material resulted in discoloration of the Corning 1723 glass specimen when subjected to electron radiation. Twenty-four hours after exposure, permanent internal cracks developed in the specimen. The extent of discoloration and cracking as a function of electron and proton radiation levels is undergoing further laboratory investigation.

The window cover design was simplified by substitution of a fixed high-temperature outside pane (parallel to the present inner pane) to replace the mechanically operated window covers.

Guidance and Control

Optical range requirements for checking the alignment of the navigation and guidance subsystem at S&ID were studied jointly with MIT. A basic surveying scheme requiring a minimum unobstructed angle of view of 100 feet at 44 degrees was proposed. Plans for mounting autocollimators on a fixture hanging from the command module or on a tower were proposed as alternate methods. It has been determined that sway measurements must be made on the command module when it is installed on the service module. These measurements will yield tolerance figures that will aid the design of alignment test fixtures. When these sway tolerances are determined, the studies with MIT will be continued.

A survey of stabilization and control subsystem (SCS) power requirements was made. The conclusions of the study indicated that the over-all SCS requirements for a 14-day mission are 49 kw hours.

Simulation of typical flight problems (including entry) were performed in the Minneapolis-Honeywell simulator, using both the T-handle with Gemini-type hand controllers and the two proposed flight director attitude indicator (FDAI) displays. Several astronauts performed the simulated runs. Evaluation of the test data will be performed at a joint S&ID, NASA, and Mineapolis-Honeywell meeting during the next report period. It is anticipated that resolution of the hand controller and FDAI problem area will be accomplished at that time.

During the report period, an analysis of the effect of pseudo-rate cutout during manual maneuvers was completed by Minneapolis-Honeywell. The present automatic flight control system mechanization contains a constant pseudo-rate feedback gain in the switching amplifier. A wide variation in spacecraft inertias during the midcourse phase of the lunar orbiting rendezvous mission requires a compromise in the pseudo-rate gain that results in an undesirable amount of jet pulsing during maneuvers with large spacecraft inertias. This increases fuel consumption because of jet inefficiency for short impulses.

An analog computer study was conducted to evaluate the significance of this jet pulsing on mission fuel consumption and to determine what system modifications can be made to minimize these effects. The following recommendations are the result of the analog computer study in which the parameter changes in question were studied and verified. Manual rate commands (step-inputs) were simulated for various values of reaction jet acceleration capability (corresponding to variations in spacecraft inertia through the lunar orbital rendezvous mission), and time histories of spacecraft rate, attitude, pseudo-rate, jet pulsing frequency, and fuel-consumption were recorded.

1. If pseudo-rate feedback is disabled during manual rate maneuvers, a reaction-jet fuel saving of greater than 30 pounds for the midcourse phase of the lunar orbital rendezvous mission will be accomplished.

2. Over 90 percent of the maneuvers made during midcourse will be accomplished by manual commands.

3. Increasing the pseudo-rate gain significantly improves stability during operation with the rate gyros shut down. It also has the effect, however, of reducing spacecraft attitude accuracy during translational maneuvers.

Based on the above, the following system changes are recommended:

1. Disable the pseudo-rate feedback during manual translational and rotational maneuvers.

2. Increase the pseudo-rate feedback gain to 1.0 degrees, and increase the switching amplifier hysteresis to 0.007 degrees.

Telecommunications

The problem in testing traveling wave tubes at Collins radio has been resolved by closer control of voltage input from the testing equipment. Traveling wave tubes are now performing satisfactorily in tests and no further problems are anticipated.

The VHF recovery beacon is being changed to an interrupted tone-modulated continuous wave beacon; no significant schedule delays should result. An integral oscillator has been added to the PCM telemetry procurement specification for use in the event of loss of synchronization signals from the central timing equipment. The 250 millivolt input channels have been changed to 40 millivolts full scale and the five-point calibration capability has been changed to a two-point calibration.

The addition of VHF up-data link equipment to the spacecraft has been initiated. An implementation plan and a rough draft copy of the equipment procurement specification have been submitted to NASA. This VHF up-data link equipment enables information to be transmitted from ground to spacecraft for automatic display to the astronaut.

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Instrumentation

The instrumentation previously installed in boilerplate 6 has been revised. The instrumentation now incorporates conical surface pressure transducers that have a range of 2 to 22 psia as compared with the 15- to 30-psia range capability previously available. A new instrumentation wiring harness has been installed.

Telemetry channels have been assigned and provisions made to monitor the launch escape motor chamber pressure and the pitch control motor chamber pressure for boilerplate 6.

Breadboard tests of instrumentation for boilerplate 12 have been completed successfully. Components for boilerplate 13 instrumentation are arriving at Downey and are being calibrated and functionally verified.

Complete instrumentation equipment lists for the propulsion systems qualification test vehicles (spacecraft 001 and test fixture F-2) were released. Installation design for instrumentation on F-2 has been released, and that for spacecraft 001 will be completed during the next report period. Procurement specifications have been prepared for the required instrumentation components.

Environmental Control Subsystem (ECS)

The water management system has been simplified by completely separating it from the Freon system. This separation was accomplished by installing a pre-filled 10-pound Freon tank in the left-hand equipment bay. Previously, Freon was supplied by GSE to the waste water tank for use as a coolant during prelaunch and boost. Concurrently, to accommodate the Freon, waste water formed during prelaunch and boost was ejected overboard. The provision of a pre-filled Freon tank not only simplifies the water system but adds to its safety since waste water now can be stored as a potential emergency coolant.

A reevaluation of water usage curves together with consideration of the 18 pounds of water in the crew survival kit have resulted in a reduction of the storage capacity of the potable water tank from 64 to 36 pounds. The tank has also been moved from the aft equipment bay in the exterior portion of the command module to the lower equipment bay inside the command module cabin. This change protects the tank from potential impact damage during landing and makes available, without pressurization, an additional supply of potable survival water.

The glycol pressure relief and shutoff valves are being moved from the service module to the main ECS package in the command module. This change will minimize the use of electrical controls in the service module. These controls actuate shutoff valves in case of a malfunction of the pressure relief valves. The shut-off valves in their new location are operated manually, eliminating electrical power provisions. The glycol fill and vent connections together with the flyaway umbilical disconnect panel in which they are located are being moved 20 degrees closer to the Z-axis in the service module to avoid interference with the RCS engines in that area.

Electrical Power Subsystems

Technical procurement specifications for the Pratt & Whitney fuel cells are nearly complete. Specifications will provide a description of the configuration of the qualified hardware and any deviation for prototype equipment.

Changes in LES and ELS sequencers for boilerplates 3, 6, 12, 13, 15, 19, and 23 have been made to improve reliability. Redundant timers, arming relays, and provisions for hardline monitoring of the status of certain pyro firing relays are being added to these sequencers. These changes were made to ensure correct LES and ELS actuation of the sequencer operation and to provide for monitoring of certain relays in the sequencers.

Development tests have been completed on the battery charger and drawings have been released for the building of qualified hardware. The unit successfully charged batteries during the breadboard tests and met all radio frequency interference requirements.

Laboratory tests were successfully completed on the d-c undervoltage and the a-c failure sensing devices. Drawings have been released for the procurement of qualified hardware.

Testing is continuing on the inverter breadboard. A study to resolve the problem of excessive ripple due to high input a-c impedance of the inverter is being carried out.

Electronic Interfaces

The entry monitor display is being redesigned to provide a g versus velocity presentation. A recent reevaluation of display requirements has revealed that a g versus time presentation is inadequate. While a g versus time display gives adequate information for the performance of a completely manual entry maneuver, the information is insufficient to monitor the navigation and guidance performance of the normal mission automatic entry.

The wiring technique study for the lower equipment bay has been completed and a mock-up of the final configuration is in process.

The procurement specifications and specification control drawings for all the main display console subpanel components have been made.

Complete redesign of the main and side display consoles is necessary. The redesign will include the size, configuration, and mounting angle to conform to the new reach and visual requirements caused by incorporation of the fixed crew couch concept. This change may affect both subcontractor and associate contractor equipment. MIT has agreed to study possible reconfigurations of the main display panel computer keyboard/readout panel.

Service Propulsion Subsystem (SPS)

Cold flow tests on the F-3 test fixture were started at Downey. Pressure system parameters indicate stable operation of the system within the design requirements. New sight gauge plumbing is required before the next run to correct tank liquid level readout problems.

The 4-inch diameter Teflon-coated tetrafluor and 0-ring seals in the SPS propellant system/engine interface flight hardware passed helium leak tests. The flight hardware is presently being set up for nitrous oxide leak tests after temperature cycling.

The SPS heat exchanger breadboard test stand has been completed and heat exchanger testing has begun.

A design layout of changes to the SPS propellant distribution system caused by relocation of the engine to improve radiation cooling has been completed. The layout reflects the revised engine propellant system plumbing interface and relocates the plumbing forward for improved engine heat dissipation.

Fifty-seven firings of the SPS engine were accomplished during this report period. Six checkout and acceptance test firings of the first engine with injector AF-30 were accomplished; two firings that demonstrated injector-propellant valve compatibility were satisfactory. Table 1 outlines all firings made during the report period.

As a standby measure, in the event of possible difficulties with current SPS engine design during altitude tests at AEDC, a modified mandrel and

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Table 1. Injector Development Test Program
Apollo Service Propulsion Engine

Serial No.	Pattern Designation and Type	Type of Evaluation	Number of Firings	Number Unstable	Remarks
AF-30	POD-31-3, Long impingement triplet	Acceptance test	2	2	Instability attributed to test stand
		Checkout	4	0	Fired in vertical stand
AF-33	PONX-51-2, PONX-51-3, Quadlet	C* Determination	6	0	C*-5482
		Injector-chamber compatibility	7	0	Excessive errosion in the throat area
AF-28	POUL-31-1, Doublet	C* Determination	5	2	Scrapped—injector face leakage
AF-27	POUL-31-1, Doublet	C* Determination	3	0	——
		Injector-chamber compatibility	2	0	Excessive streaking
AF-3	POUL-21-1, Doublet	C* Determination	2	2	Cracked face weld
AF-9	POD-31-3, Long impingement triplet	Pattern evaluation	2	0	Cracked oxidizer manifold
AF-32	POLY-31-4, Triangular triplet	C* Determination	2	2	Eliminated from program

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Table 1. Injector Development Test Program
Apollo Service Propulsion Engine (Cont.)

Serial No.	Pattern Designation and Type	Type of Evaluation	Number of Firings	Number Unstable	Remarks
BF-11 (Baffled)	POD-31-9, Long impingement triplet	C* Determination	5	0	C*-5376
AF-5	POD-31-3, Long impingement triplet	Extended duration	5	0	———
AF-1	POD-31-3, Long impingement triplet	Valve-injector compatibility	2	0	———
A-12	Subscale	C* Determination	4	-	Ablative chamber
A-13	Subscale	C* Determination	4	-	Ablative chamber
A-15	Subscale	C* Determination	3	-	Uncooled steel chamber

C* = Characteristic exhaust velocity

two thrust chambers with matching titanium nozzle extensions are to be designed and manufactured. The mandrel is to be capable of producing an expansion ratio of at least 18:1 in the thrust chambers. The two thrust chambers using the redesigned mandrel are to have an optimum expansion ratio between 6:1 and 18:1, as established by analysis.

Reaction Control Subsystem (RCS)

The bracketry interface requirements and the propellant and helium port configurations have been completed for the positive expulsion tanks of the RCS. To reduce the design and development effort and to facilitate manufacturing, all tanks will have collapsing Teflon bladders with propellant ports located on the symmetrical centerline. Previously, the command module tanks had expanding bladders, and the fuel tank bladders were Butyl rubber.

Rocketdyne conducted tests on five Phase I boilerplate engines operating in a pulse mode. Three engines subjected to simulated mission firing sequence showed that 20 millisecond pulse operation produced the most flaking and that 250 millisecond pulse operation produced the most glassing of the macerated ablative material in the combustion chamber. Simulated mission duty cycle operation resulted in the "worst" combination of the two conditions and is considered the most severe test condition to which the engines have been subjected.

Two of the Phase I engines tested contained an inner combustion chamber liner of oriented ablative material. Because flaking of this liner was found to be insignificant, Rocketdyne has modified the configuration of the prototype engine to 45-degree oriented ablative material for the inner combustion chamber liner in place of the macerated material.

Marquardt has concentrated its test efforts to reduce injector head soak-back temperatures and to improve specific impulse performance. Fifteen tests were conducted on preprototype and prototype engines. Monomethylhydrazine was used during two of the tests to determine the effect on performance and injector temperatures. A slight performance improvement was noted, but insufficient temperature data were obtained.

Four nonfireable engines and six sets of propellant valves were delivered by Marquardt to S&ID for use on boilerplate 14.

Launch Escape Subsystem (LES)

The static tower tie-down firing test was conducted during the report period. Data acquisition was approximately 97 percent successful. Preliminary motor performance data indicated both launch escape and pitch control motors performed within specifications.

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The launch escape motor for boilerplate 6 has successfully undergone nozzle retrofitting to provide for greater nozzle carbon bearing surface and smaller throat area consistant with a thrust level of 155,000 pounds at 36,000 feet. This motor plus the pitch control motor for boilerplate 6 and its spare will be ready for final shipment to WSMR during the next report period.

Tower jettison motor AD-3 was successfully fired at 20 F following 75 days of accelerated aging at 160 F. This firing verified the integrity of the interim-fix nozzle configuration that features the addition of a 0.20-inch steel spacer between the carbon and the steel shoulder of the expansion cone for greater carbon bearing surface, and the replacement of the aluminum nozzle closure with a polyurethane foam plug at the throat.

The first vibration tested tower jettison motor (AD-16) was static fired successfully. Post-firing inspection of the motor showed that all components functioned properly.

INTEGRATION

System Integration

Four lunar landing missions have been recommended for use as design criteria: (1) a 5-3/4 day 60-hour transfer mission to investigate design bases for systems, (2) an 8-day mission directed to primary mission objectives to evaluate probability of mission success, (3) a 14-day 79-hour transfer-time mission to evaluate provisioning and probability of crew safety, and (4) a 14-day 110-hour transfer mission to investigate design bases for systems. An evaluation of the spacecraft will be made against these missions and design modifications, if required, will be reported to NASA.

A detailed study has been made to determine the test requirements for spacecraft 008 (environmental proof test) to support the flights of spacecraft 009 (suborbital or orbital) and spacecraft 011 (manned orbital), and to determine the extent of environmental testing required for each system. A test matrix has been formulated for spacecraft 008 showing the level of knowledge progression on each system from an environmental standpoint and working up to those tests required for mission success and crew safety for spacecrafts 009 and 011. A detailed test plan to accomplish the necessary tests to support spacecrafts 009 and 011 has been published. The tests to be conducted consist of simulated unmanned three-orbit flights in both vacuum and non-vacuum conditions, a simulated three-orbit manned flight in a vacuum, and an extended manned orbital flight of approximately five or six orbits. Certain emergencies and malfunctions will be programed during some of these runs to verify emergency procedures.

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The Apollo - Little Joe II interface coordination document (ICD) was completed and copies forwarded to General Dynamics/Convair and NASA for review and approval. This document identifies all interfaces between boilerplate 12 and the Little Joe II booster, and defines detail requirements in all areas where firm data have been developed. Comments on the ICD from Convair are being evaluated.

Ground Support Equipment

The design concept of the special test units (STU) for integrated checkout of the spacecraft systems has been approved by NASA. The concept calls for the STU's to be interchangeable by employing standard control and display units and by featuring a standard console wiring system. This interchangeability allows hardware design to proceed without specific interface requirements for each unit. The STU will interface with the prelaunch automatic checkout equipment (PACE) signal conditioners or the analog output of a telemetry ground station. Interface problems are under study to determine site and function requirements.

A preliminary analysis of the qualification test requirements for each GSE model is being made to formulate a set of test requirements commensurate with the operating disciplines under which Apollo GSE will be required to perform. With the exception of equipment classified as "mission essential" (i.e., PACE - spacecraft carry-on), life tests were not considered necessary. Selected items of handling equipment will be subjected to destructive and non-destructive load proof tests. These tests will be scheduled upon completion of the analysis of the qualification test requirements.

The method of spacecraft 008 checkout during environmental testing at Houston has been determined as follows:

1. The environmental chamber instrumentation system will be used for measurements external to the spacecraft.

2. For down-link operation, PACE - spacecraft carry-on system and the data interleaving system will be used to transmit data to the STU consoles.

3. For up-link operation, either the PACE - spacecraft carry-on command system controlled by STU consoles or STU hardwired to the spacecraft systems will be used.

Initial design requirements have been defined for the GSE models shown in Table 2.

[redacted]

Table 2. GSE Models With Defined Design Requirements

Model No.	Item
	AUXILIARY
A14-020	Service Module Cover
A14-022	Launch Escape System Cover
	HANDLING
H14-031	Base Support Stand
H14-037	Propulsion Development Test
H14-089	N & G Polarity, Test Fixture
H14-106	Test Fixture Ground Adapter Sling
H14-107	F-2 Support Stand
H14-121	Service Module Equipment Dolly
H14-034	Fluid Distribution System
	SERVICING
S14-036	Fluid Distribution System
S14-043	Fluid Distribution

[redacted]

Reliability

In preparation for the pad abort test of boilerplate 6, analyses were made of data acquisition equipment and the launch escape sequencer, and a reliability/crew safety review was conducted. The results shown in Table 3 were obtained from logic diagram and failure effect analysis of data acquisition equipment.

Table 3. Data Acquisition Equipment Analysis

Data Acquisition	Probability of Success
Attitude and aerodynamics	0.96165
Temperatures	0.99074
Vibration	0.99324
Total Data Package	0.96918

All data except vibration information will be telemetered to the ground. In addition, all data will be tape recorded on-board to back up potentially high failure rate items. Because of these predicted probabilities for successful data acquisition, no changes to the design of data acquisition equipment are recommended.

As a result of a failure effects analysis of the launch escape sequencer for boilerplate 6, the design changes are being made in the utilization of redundant arm-disarm relays and parallel 15.5-second time-delay relays. At present there is one arm-disarm relay controlling two parallel circuits, each containing a 15.5-second time-delay relay. The addition of a second arm-disarm relay in parallel will increase reliability. The addition, in each of the two circuits, of another 15.5-second time-delay relay that operates simultaneously with the other time-delay relay in the circuit, but with electrical contacts in series, will prevent a premature firing and will further increase reliability.

OPERATIONS

DOWNEY

A planned tasks and schedules document for boilerplate 12 has been prepared and is being incorporated into the PERT network. A preliminary study has been made and facility changes requested to support a mated, integrated test on boilerplate 12. The test will simulate the WSMR configuration.

The boilerplate 13 instrumentation breadboard checkout procedure has arrived from NASA; the interim area layout for boilerplate 13 has been reviewed and changes have been incorporated.

Requirements have been coordinated on previously undefined test parameters for the premodulation processor central equipment and for the television station. These requirements will affect boilerplate 14 operational test procedures.

Hardwire monitoring of data pickoff points is now provided for boilerplate 6, instead of only an air-link monitor. New command module and forward compartment harness, modification of the test conductor's console, and new launch escape subsystem- (LES) earth landing system (ELS) sequencers are in work.

A special WSMR transportation simulation for boilerplate 6 was accomplished, following the LES-command module, gross weight/ center of gravity, and thrust vector alignment procedure. This activity simulated transport from the WSMR checkout hangar to the launch pad. The verification check disclosed the alignment to be well within the allowable tolerance of 0.1 inches, with an actual measurement of 0.015 inches.

The A14-003 pyrotechnic device substitute unit is now awaiting NASA approval of material review disposition concerning the hot wire/explosive bridge wire box rework.

The WSMR and AMR technical range data requirements have been tabulated and released to Test Integration for inclusion in the master measurement list.

WHITE SANDS MISSILE RANGE

Construction of the WSMR mission abort vehicle assembly building was started on 24 April 1963, and the building column foundations have been poured. The electrical installations for the pad abort J-box are continuing, and the checkout cable connector installation has started. Forming for the walls of the power house is nearing completion. The 500-foot weather tower near the pad abort launch complex, the access roads, and the road from the main access road to the hardstand have been completed.

The umbilical tower for the Little Joe II launcher has been erected and the wiring started.

ATLANTIC MISSILE RANGE

The PERT network for boilerplate 13 was revised. This revision reflects the new Master Development Schedule 6, covering 9 weeks Downey checkout and 11 weeks AMR field operations.

The GSE utilization list for boilerplates 13, 15, and 18 reflecting the current Apollo Test and Operations need dates was prepared. The need dates indicated were based on Master Development Schedule 6.

LOGISTICS SUPPORT

Training

The initial training analysis has been completed, showing that NASA will have a minimum GSE training requirement through spacecraft 009.

Format and content requirements of the Apollo part-task trainer instructor manual were completed.

Supply Support

Airborne spares released to date total 1400 line items, an increase of 550 spares released during the report period.

Amended shipping instructions for boilerplate 6 GSE, GSE spares, and bulk items have been issued directing shipment to WSMR. GSE end items will be held at Downey until Apollo Test and Operations completes their test preparation functions.

Manuals

All boilerplate 6 manuals with the exception of those associated with the LES and ELS sequencer changes were delivered to NASA.

Logistics Engineering

Changes requested by NASA to the maintenance concept, maintenance plan, and support plan have been completed.

The GSE Planning and Requirements document is being revised. It will be published during the next report period.

[redacted]

FACILITIES

INDUSTRIAL ENGINEERING

Considerable rehabilitation and clean-up was accomplished in the static test tower to accommodate the combined module mating and static test operations.

Verbal approval was obtained this week for the Apollo antenna test range. Both NASA and S&ID agree that the site selected should be near the Downey operations.

The rehabilitation of the Northrop-Ventura administration and parachute packing buildings was completed this week.

Completion of the area layout of the space systems development facility is anticipated during the next report period.

The special autoclave in the new bonding facility is expected to be in operation during the next report period.

FACILITIES PROJECTS

Systems Integration and Checkout Facility

The general contractor began work on 18 April 1963. Pouring of the concrete foundation piles has been completed, forming for the pile caps and excavation for the tie beams has been started, the underground fire main has been completed, and underground electrical work has begun.

APPENDIX A

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

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S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS
16 April to 15 May 1963

Subject	Location	Date	S&ID Representatives	Organization
Interface discussion	Huntsville, Alabama	16 April	Hogan, Martin	S&ID, NASA
Materials engineering conference	Indianapolis, Indiana	16 April	Krainess	S&ID, GMC-Allison
GSE interface resolution	White Sands, New Mexico	16 April	Jacob, Handlow	S&ID, NASA
Quality control meeting	Houston, Texas	16-17 April	Griffith-Jones	S&ID, NASA
IFTS requirements discussion	Cedar Rapids, Iowa; Minneapolis, Minnesota	16-17 April	Puterbaugh, Rose, Fitzpatrick	S&ID, Collins S&ID, Minneapolis-Honeywell
Communications and instrumentation meeting	Houston, Texas	16-17 April	Page, Dorrell, Robinson, Nowiciki, Beeler	S&ID, NASA
Rotational control review	Minneapolis, Minnesota	16-17 April	Campbell, Susser	S&ID, Minneapolis-Honeywell
Mechanical systems integration meeting	Houston, Texas	16-17 April	Underwood, Olson, Oder, Kraft, Haglund, Ellis, Marshall, Smith, Pollard	S&ID, NASA
Final subcontract negotiations	Bethpage, Long Island, New York	16-17 April	Moore, Wishon	S&ID, Alderson Research Labs

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Subject	Location	Date	S&ID Representatives	Organization
Technical information exchange	Cambridge, Massachusetts	16-17 April	Kasten	S&ID, MIT
Contract negotiations	Chicago, Illinois	16-23 April	Greenfield, Travis, Weiss, Forrette, White, Cason	S&ID, Elgin
Checkout panel discussion	Houston, Texas	16-18 April	Shelley, McMilin, Bradanini, Siwolip, Jacobson, Lindley, Dorman	S&ID, NASA
Advisory committee research	Moffett Field, California	16-18 April	Skene	S&ID, Ames
Weighing system tests	AMR	16-26 April	Hedger	S&ID, NASA
Measurement requirements coordination	Houston, Texas	16-19 April	Eckmeier, Jones Charnock, Jarvis, Schmitz, Harper, Langmore, Witxtrom	S&ID, NASA
Field analysis	Highstrom, New Jersey	17 April	Dwyer, Ship, Schear, Moreno	S&ID, RCA, Airborne Instrumentation Lab
Units review	Cincinnati, Ohio	17 April	Fazioli	S&ID, Keco Industries
Design coordination	Tulsa, Oklahoma	17-19 April	Vendl, Myers, Cox	S&ID, S&ID-Tulsa
Boilerplate preparation coordination	El Centro, California	17-22 April	Brayton, Casey, Ellis, Poole	S&ID, 6511th Test Group

Subject	Location	Date	S&ID Representatives	Organization
Contract negotiations	Indianapolis, Indiana	17-24 April	Moore, Perry, Parry, Ellis, Tapper, Milliken	S&ID, GMC-Allison
Field analysis	Binghamton, New York	17-26 April	Banton, Fulton, Hatchell, Cooper, Marshall, Clark, Mathews, LaFrance, Kerr	S&ID, General Precision
Stabilization and control meeting	Houston, Texas	18 April	Antletz, Miller, Jarvis, Peterson, Murad	S&ID, NASA
LEM TV common usage integration	Houston, Texas	18 April	Green	S&ID, NASA
Discrepancies and procedures investigation	Wilmington, Massachusetts	18-19 April	Harris, Allen	S&ID, Avco
Checkout discussion	Houston, Texas	19 April	DaVanzo	S&ID, NASA
Test setup inspection	Tullahoma, Tennessee	19-23 April	Woody	S&ID, AEDC
Engineering representative	Houston, Texas	19 April 3 May	Severine	S&ID, NASA
Engine tests	Sacramento, California	20 April	Mower, Ross, Szalwinski	S&ID, Aerojet-General
Space feeing conference	Atlantic City, Georgia; Chicago, Illinois; Denver, Colorado	20-24 April	Voss	Symposium S&ID, QMECI S&ID, USA Medical Research and Nutrition Lab

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Subject	Location	Date	S&ID Representatives	Organization
PERT network construction	Boulder, Colorado	21-24 April	Weizer, Seatt	S&ID, Beech Aircraft
Crew systems meeting	Houston, Texas	21-24 April	DeWitt	S&ID, NASA
CCTV training use	Denver, Colorado	21-26 April	McNeese	S&ID, Martin-Denver
AIAA meeting	Dallas, Texas	22 April	Bellamy, Field, McCarthy	Symposium
Contract negotiations	Los Angeles, California	22 April	Seible	S&ID, AiResearch
Field analysis	Melville, Long Island, New York	22 April	Dwyer, Shaw	S&ID, Airborne Instrumentation Lab
Logistics supply support problems	El Centro, California	22 April	Bonn, Cockerell	S&ID, USN
Pretest conference and plasma test	Chicago, Illinois	22 April	Monda	S&ID, University of Chicago-Midway Labs
Guidance analysis panel meeting	Moffet Field, California	22 April	Louie, O'Malley, Myers	S&ID, Ames
Crew safety meeting	Huntsville, Alabama	22 April	Vucelic, Oliver	S&ID, NASA
Pressure suit training	San Diego, California	22-23 April	Donaldson, Carnes, Smith, Rhinehart	S&ID, North Island Naval Training Station

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Subject	Location	Date	S&ID Representatives	Organization
Contract definitization	Wilmington, Massachusetts	22-24 April	Axer, Weller, Felis	S&ID, Avco
Test evaluation	Sacramento, California; Sunnyvale, California	22-25 April	Jiblits	S&ID, Liquid Rocket Plant S&ID, Lockheed
Design and g factors structure	Downey, California	22-26 April	Jobson	S&ID, NASA, Hamilton Standard
American welding conference	Philadelphia, Pennsylvania	22-26 April	Harrison	Symposium
Engineering coordination	El Paso, Texas; Philadelphia, Pennsylvania	22-27 April	Bergeron, Griggs	S&ID, NASA S&ID, TCC
Tooling coordination	Boulder, Colorado	23 April	Westfall, Carnevale, Kinsinger	S&ID, Beech
Cabling requirements coordination	Cocoa Beach, Florida	23 April	Wright, McCoy, Dorian, Dorman	S&ID, NASA
Mission planning panel meeting	Houston, Texas	23 April	Rider, Kakuske	S&ID, NASA
Environmental proof test program meeting	Houston, Texas	23 April	Overman, O'Brien, Williamson, Altenbernd	S&ID, NASA
Decommutator requirements review	Melbourne, Florida	23-24 April	Hemond, Humphrey	S&ID, NASA, Radiation

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Subject	Location	Date	S&ID Representatives	Organization
Decontamination equipment inspection	Sacramento, California	23-24 April	Lewis, Vendl, Melink, Bauserman	S&ID, Aerojet-General
Biomedical engineering meeting	San Diego, California	23-24 April	Thorton, Hayes	Symposium
Master tooling and radio equipment discussion	Cedar Rapids, Iowa	23-24 April	Brundin, Kahne, Bateman, Fleck, Best	S&ID, Collins
Coordination meeting	Cambridge, Massachusetts	23-25 April	Todd, Ryker, Zeitland, Day, Richie, Moreland	S&ID, MIT
Radiation environment meeting	Greenbelt, Denver, Colorado	23-25 April	Fletcher	S&ID, Goddard High Altitude Observatory
GSE coordination	Houston, Texas	23-25 April	Kiehlo	S&ID, NASA
Test site familiarization	Cocoa Beach, Florida	23-26 April	Norbut, Hisey	S&ID, NASA
Instrumentation coordination	Melbourne, Florida	23-26 April	Hemond	S&ID, NASA
GSE coordination	Houston, Texas	23-25 April	Bagnall, Embody, Monfort	S&ID, NASA
Hand control meeting	Minneapolis, Minnesota	23-26 April	Campbell	S&ID, Minneapolis-Honeywell
Pacific sociological conference	Portland, Oregon	24 April	Wolfe, Cave	Symposium

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Subject	Location	Date	S&ID Representatives	Organization
Altitude test coordination	Tullahoma, Tennessee	24 April	Eberle	S&ID, AEDC
Coordination meeting	Los Angeles, California	24 April	Lohwasser	S&ID, Selective Enterprize
Technical liaison	Metuchen, New Jersey	24 April	Guimont	S&ID, Applied Electronics
Contract negotiations	White Sands, New Mexico	24 April	Dunlop, Maleck	S&ID, NASA
GSE coordination	Houston, Texas	24-25 April	Embody, Gebhardt	S&ID, NASA
Facility survey	Farmingdale, Long Island, New York	24-25 April	Bray, Martini Malanczuk, Shea, Briedewell	S&ID, Aerodyne
Mock-up review	Houston, Texas	24-25 April	Muramatsu, Dziedziula	S&ID, NASA
Flight technology panel	Houston, Texas	24-26 April	Dudek, Dodds, Fouts, Gershun, Hobbs	S&ID, NASA
GSE design review	Tulsa, Oklahoma	25 April	Kendrew, Vilven	S&ID, S&ID-Tulsa
Engine requirements and equipment evaluation	Sacramento, California	25 April	Bauserman, Mower, Errington, Vendl, Melink, Lewis	S&ID, Aerojet-General
Polarity checker coordination	Tulsa, Oklahoma	25 April	Burns, Palmer	S&ID, S&ID-Tulsa

Subject	Location	Date	S&ID Representatives	Organization
Reporting format and IBM program coordination	Houston, Texas	25 April	Dunn, Irwin	S&ID, NASA, Grumman
Pretest conference	Tullahoma, Tennessee	25 April	Moote	S&ID, AEDC
Heat shield interchange meeting	Wilmington, Massachusetts	25-26 April	Hanifin, Johnson, Lundgren, Confer, Morant, Gershun, Nelson, Kerr	S&ID, Avco
Crew systems meeting	Houston, Texas	25-26 April	Brewer, Hornic, Tarr, Laubach, Raymes, Edgerly, Ross, Salitarw	S&ID, NASA, Grumman, Perkins-Elmer
Contract coordination	Houston, Texas	26 April	Maleck, Dunlap, Foist, Blue	S&ID, NASA
PSDF review	Las Cruces, New Mexico	28 April 3 May	Landstrom	S&ID, NASA
Contract negotiations	Cedar Rapids, Iowa	28 April	Shear, Blakeley, Hagelberg	S&ID, Collins
Boilerplate modification	Newberry Park, California	28 April 10 May	Perry	S&ID, Northrup-Ventura
Boilerplate modication	El Centro, California	28 April 10 May	Young	S&ID, NAF
TV camera modifications discussion	Princeton, New Jersey	29 April	Green	S&ID, RCA
Contract negotiations	Minneapolis, Minnesota	29 April	Rothacher, Cagni, Canon	S&ID, Minneapolis-Honeywell

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Subject	Location	Date	S&ID Representative	Organization
Subcontractor cost negotiations	Cedar Rapids, Iowa	29 April	Hagelberg, Blakely	S&ID, Collins
Briefing presentation	Bethpage, Long Island, New York	29 April	Wineman	S&ID, Grumman
Contamination conference	Boston, Massachusetts	29 April	Diurni, Errington	S&ID, NAA-Cocoa Beach
Monthly coordination	Cocoa Beach, Florida	29 April	Moore	S&ID, NAA-Cocoa Beach
Technical presentation	St. Louis, Missouri	29 April	Frost	Symposium
SAE meeting—lamps and illumination	Washington, D.C.	29 April	Olesen	Symposium S&ID
Negotiations discussion	Hartford, Connecticut	29 April 3 May	Snyder	S&ID, Pratt & Whitney
Organizational problems resolution	Buffalo, New York	30 April	Myers, Hobson, White, Johnson, Gibb	S&ID, Bell Aerospace Systems
Mission planning panel participation	Houston, Texas	30 April	Myers, Rider, Kakuske	S&ID, NASA
Firing observation	Sacramento, California	30 April	Mower	S&ID, Aerojet-General
Jet plume test	Tullahoma, Tennessee	30 April	Piesik	S&ID, AEDC

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Subject	Location	Date	S&ID Representatives	Organization
Design parameter establishment	Scottsdale, Arizona	30 April	D'Ausilio, Isreal, Balodis	S&ID, Motorola
Electromagnetic radiation hazards congress	Philadelphia, Pennsylvania	30 April 2 May	Holloway, Hitchens, Silverman	S&ID, The Franklin Institute
Engineering coordination	Boulder, Colorado	30 April 2 May	Ryan	S&ID, Beech Aircraft
Subcontract definitization	Cedar Rapids, Iowa	30 April	Comensky, Lanxner	S&ID, Collins
Logistics documentation coordination	Culver City, California	1 May	Johnson	S&ID, Anroux
Paper delivery	Davenport, Iowa	1 May	Robinson	S&ID, IEEE
TV compatibility discussion	Houston, Texas	1 May	Green	S&ID, NASA
Calibration Conference	AMR	1 May	Donaldson	S&ID, NASA
GOSS discussion	Houston, Texas	1 May	Kennedy, Louie	S&ID, NASA
Spacecraft operations meeting	Houston, Texas	1 May	Jones, Miller, Miliken	S&ID, NASA
In-flight test and measurements meeting	Cedar Rapids, Iowa	1 May	Wixtrom, Hudelson	S&ID, Collins
Lubrication conference	New York City, New York	1-2 May	Korb, De Laat	Symposium
Cost negotiations meeting	Cedar Rapids, Iowa	1-3 May	Newman, Bange	S&ID, Collins

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Subject	Location	Date	S&ID Representatives	Organization
Fact finding meeting	Minneapolis, Minnesota	1-4 May	Mihelich	S&ID, Minneapolis-Honeywell
Flight test reporting	Houston, Texas	2 May	Ryan, Wang, Graham	S&ID, NASA
Pressure tests	Houston, Texas	2 May	Allen, Davey	S&ID, NASA
Guidance analysis panel meeting	Houston, Texas	2 May	Louie, Fouts, Frank, Johnson, Kennedy, Notts	S&ID, NASA
GSE design status discussion	Tulsa, Oklahoma	2 May	Robertson, Wilson	S&ID, S&ID-Tulsa
Checkout measurements discussion	Cocoa Beach, Florida	2-3 May	Schmitz, Hunter, Harper	S&ID, NAA-Cocoa Beach
Systems concept briefing	Tulsa, Oklahoma	2-3 May	Donaldson	S&ID, S&ID-Tulsa
Design engineering inspection	San Diego, California	3 May	Osbon, Pyle	S&ID, Convair
Circuitry evaluation	Sunnyvale, California	3 May	Perkins, Cason, Forrette	S&ID, Signetics
Thermal and propulsion analysis	Chicago, Illinois; Bethpage, Long Island, New York	3-6 May	McCarthy, Cool, Kinsler, Simkin, Hackett, Merhoff, Laubach, Reichmaier, Stelzriede	S&ID, Wacker & Madison S&ID, Grumman
Test methods and scheduling meeting	Sunnyvale, California	3-8 May	Allen	S&ID, Thermatest Labs
R & D vehicle coordination	Houston, Texas	3-10 May	Baum	S&ID, NASA
Coordination effort	El Centro, California	4 May	Ronneberg	S&ID, USN

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Subject	Location	Date	S&ID Representatives	Organization
Contract negotiations	Downey, California	5 May	VanValkenburg	S&ID, Minneapolis-Honeywell
Engineering and purchasing coordination	Middletown, Ohio	5-7 May	Kerr	S&ID, Arenoca
Fuel cell test plan coordination	Hartford, Connecticut	5-9 May	Scott, Brown, Nelson	S&ID, Pratt & Whitney
AICEP meeting and thermodynamics discussion	Buffalo, New York; Bethpage, Long Island, New York	6 May	Oki, Solitario	Symposium S&ID, Grumman
Logistics data coordination	Palos Verdes, California	6 May	Dortch, George, Fore, Robert	S&ID, Nortronics
Visual problems discussion	Dayton, Ohio	6 May	Beam	S&ID, Wright-Patterson Air Force Base
Support manual meeting	Newberry Park, California	6 May	Otterstein, Lanxner	S&ID, Northrop-Ventura
Test program coordination	Jonesville, Pennsylvania	6-8 May	Oliver, Holm, Hornick	S&ID, Aviation Medical Acceleration
Simulation personnel coordination	Columbus, Ohio	6-10 May	Krimgold	S&ID, NAA-Columbus
Delivery schedule and development plan	Hartford, Connecticut	6-12 May	Toomey, Riddle, Van Camp	S&ID, Pratt & Whitney
Life systems requirements coordination	Columbus, Ohio	6-17 May	Ballinger, Thesing	S&ID, NAA-Columbus
Subcontractor cost negotiations	Cedar Rapids, Iowa	7 May	Newman, Bange	S&ID, Collins

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Subject	Location	Date	S&ID Representative	Organization
Crew safety meeting	AMR	7 May	Vucelic, Pape	S&ID, NASA
Logistics data coordination	Culver City, California	7 May	Johnson, Comensky	S&ID, Arnoux
Optical properties and radiation efforts	Corning, New York	7 May	Beam	S&ID, Corning
Propulsion systems meeting	Houston, Texas	7 May	Bellamy, Eldrige, Beatty, Svenson, Simkin	S&ID, NASA
Mission planning meeting	Houston, Texas	7-8 May	Clary, Miller, Myers	S&ID, NASA
Visual detection and tracking discussion	Bethpage, Long Island, New York	7-8 May	Chinn	S&ID, Grumman
Environmental proof test meeting	Houston, Texas	7-9 May	Overman, Aber, Williamson, Cole, Altenbernd	S&ID, NASA
Testing procedures	Indianapolis, Indiana	7-9 May	Arnold, Tedisco	S&ID, GMC-Allison Division
Mechanical integration panel meeting	Houston, Texas	7-10 May	Johnson, Nicholas, Helms, Tooley, White	S&ID, NASA
Simulation requirements and negotiations	Minneapolis, Minnesota, Columbus, Ohio	7-11 May	Barnett, Frimtzis	S&ID, Minneapolis-Honeywell S&ID, NAA-Columbus
GSE interface meeting	Downey, California	8-9 May	Moreland, Todd, Percy	S&ID, MIT
Engineering coordination	Boulder, Colorado	8-9 May	Bouman	S&ID, Beech
Crew safety panel meeting	Houston, Texas	8-9 May	Cureton	S&ID, NASA

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Subject	Location	Date	S&ID Representatives	Organization
Stabilization and control and flight technology meeting	Houston, Texas	8-10 May	Goldman, Hogan, Jensen, Burnett	S&ID, NASA
Stabilization and control meeting	Minneapolis, Minnesota	8-10 May	Gasparre, Frost	S&ID, Minneapolis-Honeywell
Design coordination	Tulsa, Oklahoma	8-10 May	Davis, Cox	S&ID, S&ID-Tulsa
Control room display and checkout discussion	AMR	8-14 May	Grycel, Wixtrom, Rousculp	S&ID, NASA
Operations review	White Sands, New Mexico	8-15 May	Feltz, Moore, Paup, Pearce, Pyle	S&ID, NASA
Field analysis	Newberry Park, California	8-17 May	Beatty	S&ID, Northrop-Ventura
Docking studies	Columbus, Ohio	9 May	Lilley, Johnson	S&ID, NAA-Columbus
Umbilical hose tests evaluation	Houston, Texas	9 May	Roentgen, Paulsen	S&ID, NASA
Irradiation tests	Oak Ridge, Tennessee	9-10 May	Okumura	S&ID, Oak Ridge National Lab
Pretest conference	Moffett Field, California	10 May	Vardoulis, Allen, Takvorian, Davey, Sandberg, Stevens	S&ID, Ames
Logistics data coordination	Pasadena, California	10 May	Otterstein, Comensky	S&ID, Consolidated Electro-Dynamic
Handling equipment assistance	Huntsville, Alabama	10 May	Stewart	S&ID, NASA
Wind tunnel tests	Houston, Texas	10-27 May	Takvorian	S&ID, NASA

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Subject	Location	Date	S&ID Representative	Organization
Parachute drop test	El Centro, California	10 May 7 June	Ellis, Young, Rodier, Trebes	S&ID, 6511th Test Group
Engine assembly and test follow-up	Sacramento, California	10-13 May	Ross, Borde	S&ID, Aerojet-General
Mission meeting	Cocoa Beach, Florida	10-14 May	Paup, Feltz, Pyle, Pearce	S&ID, NAA-Cocoa Beach
Crew checkout coordination	Bethpage, Long Island, New York	10-14 May	Levine	S&ID, Grumman
Scheduling conference	Tullahoma, Tennessee	10-15 May	Woody	S&ID, AEDC
Test panel meeting	Houston, Texas	11-16 May	Paup, Pearce, Pyle	S&ID, NASA
Spares test support verification	El Centro, California	12 May	Rimmer	S&ID, 6511th Test Group
Docking simulation study	Columbus, Ohio	12-18 May	Scheiman	S&ID, NAA-Columbus
Engineering surveillance	Huntsville, Alabama	12-20 May	Smith	S&ID, NASA
Wind tunnel test	Tullahoma, Tennessee	12 May 7 June	Moote	S&ID, AEDC
Maintenance and requirements coordination	White Sands, New Mexico	13 May	Heaps	S&ID, NASA
NAE conference	Dayton, Ohio	13 May	Dwinell	Symposium
Design release coordination	Elkton, Maryland	13-14 May	Babcock, Gorman	S&ID, Thiokol
Circuit design and weight meeting	Phoenix, Arizona	13-14 May	Hall, Hall	S&ID, Motorola

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Subject	Location	Date	S&ID Representative	Organization
Jet plume test	Tullahoma, Tennessee	13-14 May	Kinsler, Koppang	S&ID, AEDC
Work transfer coordination	Tulsa, Oklahoma	13-15 May	Farner	S&ID, S&ID-Tulsa
Transducer and instrumentation review	Huntsville, Alabama	13-15 May	Jiblits, Boothe	S&ID, NASA
GSE design discussion	Tulsa, Oklahoma	13-16 May	Robertson	S&ID, S&ID-Tulsa
Tolerance dimensions definitization	East Alton, Illinois	13-16 May	Stefins, Miller Daoussis, Ragget	S&ID, Olin-Matheson
Contract change negotiations	Elkton, Maryland	13-17 May	Felis	S&ID, Thiokol
Program surveillance	Hartford, Connecticut	13-17 May	Frankhouse	S&ID, Pratt & Whitney
Contract negotiations	Newberry Park, California	13-24 May	Cagni	S&ID, Northrop-Ventura
Ablative test coordination	Tullahoma, Tennessee	13-31 May	Field, Eberle, Lofland, Svenson	S&ID, AEDC
Contract negotiations	Houston, Texas	14 May	Lindley, Lashbrook	S&ID, NASA
Common system study briefing	Downey, California	14 May	Lane	S&ID, Grumman
Displays and control meeting	Downey, California	14-15 May	Todd, Zeitlin	S&ID, NASA, MIT
Test panel meeting	Houston, Texas	14-15 May	Williamson, Cole, Cooper, Spengler, Ryan, Gore, Gustavson	S&ID, NASA
Monthly coordination	Rolling Meadows, Illinois	14-16 May	Perkins, Cason	S&ID, Elgin

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Subject	Location	Date	S&ID Representative	Organization
Engineering coordination	Elkton, Maryland	14-17 May	Bergeron, Reed, Hobson	S&ID, Thiokol
Monthly review	Melbourne, Florida	14-18 May	Rutkowski, Bly, Britton, Sublett, West	S&ID, Radiation
Antenna recovery	New York, New York	14-22 May	Brooks	S&ID, Airborne Instrumentation Lab
Transonic tests discussion	Houston, Texas	15 May	McNary	S&ID, NASA
Requirements coordination	Houston, Texas	15-16 May	Alpert	S&ID, NASA
Pressure suit indoctrination	San Diego, California	15-17 May	Armstrong	S&ID, North Island Naval Training Station
Facility evaluation	Sacramento, California	15-17 May	DeVries, Relyea, Bettis, Tracy, Harcos	S&ID, Aerojet-General
Boilerplate coordination	White Sands, New Mexico	15-17 May	Ginley	S&ID, NAA-White Sands
Thermal interface	Cambridge, Massachusetts	15-17 May	Percy, Phillipe	S&ID, MIT
Fluid distribution meeting	Tulsa, Oklahoma	15-17 May	Barajas	S&ID, S&ID-Tulsa
Boilerplate coordination	Houston, Texas	15-17 May	Barmore	S&ID, NASA
Rate investigation	Binghamton, New York	15-19 May	Banta, Hatchell	S&ID, General Precision
Contract change negotiations	Hartford, Connecticut	15-31 May	Barker, Snyder	S&ID, Pratt & Whitney
Fuel cell meeting	Hartford, Connecticut	15 May 3 June	Tayne	S&ID, Pratt & Whitney

[redacted]

APPENDIX B

DOCUMENTATION LIST

[redacted]

DOCUMENTATION LIST

The following documents were published during the report period:

SID 62-99-15	Monthly Weight and Balance Report for the Apollo Spacecraft
SID 62-384-30	Drawing List, Apollo Spacecraft, Complete
SID 62-1043	Structural Analysis of the Apollo 0.085-Scale FSJ-1 Force Model
SID 62-1144	Data Report for Apollo FSL-1 Model Wind Tunnel Tests in the A and B Tunnels of the AEDC Von Karman Gas Dynamics Facility
SID 63-84	Data Report of Apollo FS-2 Static Force Model in NAA Trisonic Wind Tunnel
SID 63-96	Data Report of 0.055-Scale Apollo Dynamic Stability (FD-2) Model Tests in the Langley Unitary Plan Wind Tunnel, Low Mach Leg, to Determine Flow Separator Effects
SID 63-139	Apollo Transportation and Handling Procedures
SID 63-145	Data Report for Apollo Model FS-2 Tests in the Ames Unitary Plan Wind Tunnels to Measure Launch Escape Vehicle Component Loads
SID 63-180	Apollo Documentation List
SID 62-223	Apollo GSE Maintenance On-Board Recorder Checkout Unit

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SID 63-224	Apollo GSE Maintenance Antenna Checkout Kit
SID 63-226	Apollo GSE Maintenance Data Recording Group, Model C14-020; and Signal Conditioner Console, Model C14-135
SID 63-227	Apollo GSE Maintenance Pyrotechnics Bench Maintenance Equipment
SID 63-316	Pretest Report for Tests of Apollo Free-Oscillation, Dynamic Stability Models in the AEDC VKF Tunnel A
SID 63-328	Apollo In-Flight Maintenance Concept
SID 63-364	Project Apollo End Item Specification Boilerplate 6
SID 63-394	Apollo Program Boilerplate 6 End Item Test Plan
SID 62-566-29	Still Photographs, Launch Escape System Tower Tooling Area, Command Module Boilerplate Test Capsule, Command Module Boilerplate 2 Water Impact Test 17
SID 62-367-60	Motion Picture Photography, Mobility Evaluation in Command Module Using International Latex Corporation Prototype Full Pressure Suits
SID 62-367-64	Motion Picture Photography, AiResearch Tests of an R & D Centrifugal-Type Water Separator and Development Tests of the Water-Glycol Subsystem
SID 62-367-65	Motion Picture Photography, Lockheed Pitch Control Motor at Redlands, California, Plant

[redacted]

SID 62-367-66	Motion Picture Photography, Waste Water Evaluation for Drinking Purposes, Test Conducted at NAA Torrance Facility on 4 April 1963
SID 62-367-67	Motion Picture Photography, Fabrication of Boilerplate 22 at S&ID Downey During March and April 1963
SID 62-367-68	Motion Picture Photography, Fabrication of Boilerplates 14 and 23 and Work on the Forward Covers
SID 62-367-69	Motion Picture Photography, Land and Water Impact and Stability Tests on Command Modules 1 and 2, and Boilerplate 1
SID 62-367-70	Motion Picture Photography, Marquardt Corporation Deals with the Floturn Process of Fabricating Molybdenum Thrust Chambers for the Apollo RCS Engines

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